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(54) **Combustion promoting device and method for using it**

(57) A combustion promoting device comprising a heat resistant substrate with ceramic and titanium oxide attached thereto disperses ionized clusters of cohering atoms or molecules charged with electricity and makes said ionized clusters into fine particles, said ionized clusters constituting a combustible fluid to be supplied into a combustion equipment and to cause a combustion re-

action.

This combustion promoting device enhances the combustion efficiency in a combustion equipment and thereby reduces the content of such harmful substances as NOx, SOx, HC in the exhaust gas and makes the life of the combustion equipment longer.

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Description

FIELD OF THE INVENTION

5 **[0001]** The present invention relates to a combustion promoting device and a method for using it, and in particular, for example, to a combustion promoting device for enhancing combustion efficiency in a combustion equipment such as an internal combustion engine and thereby improving fuel economy and reducing harmful substances such as NOx, SOx, HC (hydrocarbon) contained in the exhaust gas, and a method for using it.

10 DESCRIPTION OF THE PRIOR ART

[0002] A gasoline engine, taken up by way of example as one of internal combustion engines, is generally constructed to obtain power through crankshaft rotation caused by the force of a piston moving toward the bottom portion of a cylinder, in which atomized gasoline and air are at the same time delivered into a combustion chamber of the engine and sparked by a plug so as to react explosively.

15 **[0003]** In this case, the air supplied through an air intake duct into this combustion chamber streams successively in ionized clusters, bodies of cohering atoms or molecules of nitrogen and oxygen charged with positive or negative electricity.

[0004] Since the air thus delivered into the combustion chamber is in a cohering phase formed by multiple and successive ionized clusters, the fuel combustion efficiency cannot be enhanced so much even if the atomized fuel and the oxygen as a component accounting for 21% of the air are brought into an explosive reaction in the combustion chamber.

20 **[0005]** This is because adjacent clusters of oxygen which partly form the cohering phase are united through the ionic bond. Accordingly the active degree of this oxygen, which may be regarded as a scale of combustibility, is reduced. Therefore the atomized fuel cannot burn well. As a result, there occurs an incomplete combustion of such additives in the gasoline as benzene, aldehyde, antioxidant and anti-freezing agent, and a comparatively large amount of black smoke is produced, which is one of the causes of air pollution.

SUMMARY OF THE INVENTION

30 **[0006]** Considering this situation, the inventor focused attention on positive ions emitted from ceramic and titanium oxide. That is, he found out that the fuel combustion efficiency can be enhanced when these positive ions succeed in neutralizing ionized clusters of oxygen in the air delivered into the combustion chamber and thereby in dispersing and making the ionized clusters into fine particles, and completed the present invention.

35 **[0007]** The object of the present invention is to provide a combustion promoting device for enhancing the combustion efficiency in a combustion equipment and thereby reducing the content of such harmful substances as NOx, SOx, HC in the exhaust gas and for making the life of the combustion equipment longer and a method for using the device.

[0008] Further, when the combustion equipment is an internal combustion engine, the object is to provide a combustion promoting device which can improve fuel economy and increase power and a method for using the device.

40 **[0009]** The invention described in claim 1 refers to a combustion promoting device comprising a heat resistant substrate with ceramic and titanium oxide attached thereto for dispersing ionized clusters of cohering atoms or molecules charged with electricity and for making said ionized clusters into fine particles, said ionized clusters constituting a combustible fluid to be supplied into a combustion equipment and to cause a combustion reaction.

45 **[0010]** There is no restriction to the substrate material, so long as it is heat-resistant. For Example, a cloth of glass fiber (woven fabric, nonwoven fabric, knit fabric) may be employed. The material is preferably heat-resistant above 100°C. The substrate is not limited to this type of cloth. For example, the substrate may be formed into a lump. Furthermore, the substrate may be formed into a granule having a predetermined diameter or fine powder. The substrate may be liquid filled in a bag or a container.

50 **[0011]** Combustion equipment may include various combustion apparatus (boiler, stove, etc.), various internal combustion engines (gasoline engine, diesel engine, propane gas engine, jet engine, etc.) and a thermal power electric generator. Running vehicles with any of these internal combustion engines installed may include a passenger car, a truck, a bus, an auto-bicycle. Various other special utility vehicles (forklift truck, truck crane, shovel loader), a ship, an airplane may also be included.

55 **[0012]** Combustible fluids may include gasoline, light oil, kerosene, heavy oil, propane, jet fuel. Examples of other fluids are air used during the combustion and cooling water.

[0013] There is no particular restriction to the ceramics for dispersing and making ionized clusters into fine particles. Examples of such various semi-conductive substances, carbide, nitride, and boride may include alumina, feldspar, silica, granite, steatite, mica, soda glass, cordierite, barium titanate, potassium niobate, strontium titanate, barium

stannate, silicon carbide, molybdenum silicide, lanthanum chromite, zirconia, zircon, chromia, aluminum oxide, silicon nitride, aluminum nitride, gallium arsenide, beryllia, glass ceramic, mullite, ferrite.

[0014] These ceramics are classified by their functions as below.

- 5 (1) Electrically functional ceramics include such examples as a) highly insulating ceramic; Al_2O_3 , b) highly capacitive ceramic; BaTiO_3 , c) piezoelectric ceramic; PZT, SiO_2 , ZnO, d) semiconductive ceramic; LaCrO_3 , SiC, iron family oxide, BaTiO_3 , vanadium oxide, $\text{ZnO-Bi}_2\text{O}_3$, SnO_2 , e) ion conductive ceramic; $\beta\text{-Al}_2\text{O}_3$, ZrO_2 , f) thermion emitting ceramic; LaB_6 , g) secondary electron emitting ceramic; BaTiO_3 .
- 10 (2) Magnetically functional ceramics include such examples as a) soft magnetic ceramic; Zn-Mn ferrite, $\gamma\text{-Fe}_2\text{O}_3$, YIG, b) hard magnetic ceramic; SrO, $6\text{Fe}_2\text{O}_3$.
- (3) Optically functional ceramics include such examples as a) light translucent ceramic; sintered Al_2O_3 , b) light conductive ceramic; SiO_2 fiber, ZnO thin plate, c) reflective ceramic; SnO_2 , In_2O_3 , TiN, d) ceramic excited by X-ray/ultra violet ray; CaWO_4 , e) ceramic excited by infrared ray; LaF_3 (including Yb, Er), f) ceramic excited by electron; $\text{Y}_2\text{O}_3\text{S}$ (including Eu), ZnS (including Al, Cl), g) ceramic for laser; Al_2O_3 (including Cr), $\text{Y}_3\text{Al}_5\text{O}_{12}$ (including Nd), h) light emitting diode; GaAs (including Si), i) electroluminescent ceramic; ZnS (including Cu, Al), j) electro-optically effective ceramic; $\text{Bi}_4(\text{GeO}_4)_3$, PLZT, k) magneto-optically effective ceramic; YIG, l) acousto-optically effective ceramic; LiTaO_3 , LiNbO_3 , m) nonlinear-optically effective ceramic; $\text{Ba}_2\text{NaNb}_5\text{O}_{15}$.
- 15 (4) Thermally functional ceramics include such examples as a) heat resistant ceramic; ThO_2 , ZrO_2 , b) heat insulating ceramic; $\text{K}_2\text{O} \cdot n\text{TiO}_2$, $\text{CaO} \cdot n\text{SiO}_2$, c) heat transmitting ceramic; BeO, diamond.
- 20 (5) Mechanically functional ceramics include such examples as a) hard ceramic; Al_2O_3 , WC, TiC, B_4C , SiC, diamond, b) load bearing ceramic; Si_3NO_4 , SiC, reinforced glass, crystallized glass.
- (6) Biologically or chemically functional ceramics include such examples as a) bio-ceramic for artificial bone; $\text{Ca}_5(\text{F, Cl})\text{P}_3\text{O}_{12}$, Al_2O_3 , b) immobilized enzyme carrier ceramic; SiO_2 , Al_2O_3 , c) catalytic carrier ceramic; Al_2O_3 , TiO_2 , d) catalytic ceramic; $\text{K}_2\text{O} \cdot n\text{Al}_2\text{O}_3$, ferrite.
- 25 (7) Ceramics for nuclear reactor fuel include such examples as uranium oxide, uranium carbide, uranium nitride ceramics (ceramic fuel).

[0015] As said titanium oxide, for example, TiO_2 may be employed.

30 [0016] How to attach ceramic and titanium oxide to a substrate is not restricted to that described above. For example, these materials may be ground into fine powder and may be bonded onto the surface of this substrate with a binder of bonding agent. It may also be applied onto the substrate surface by spraying or may be impregnated into the substrate in some proper method. Further a lump of ceramic or titanium oxide may be attached onto the substrate surface or into the substrate.

35 [0017] Another effects of better fuel economy and higher power can be obtained by providing aluminum to the substrate. Another effect of drastically reducing smoke (black smoke), NOx, and HC in the exhaust gas can be obtained by providing copper to the substrate.

[0018] In addition to that, the effect of the present invention can further be enhanced when activated water whose cluster of water molecule is made finer is sprayed to this combustion promoting device.

40 [0019] There is no particular restriction to where to install a combustion promoting device in a combustion equipment. For example, the combustion promoting device may be installed in a storage tank for various combustible fluids, in a supply system to the combustion equipment for the combustible fluids, in a combustion chamber or in an exhaust system downstream of said combustion chamber.

[0020] The invention described in claim 2 refers to a combustion promoting device according to claim 1, in which said substrate is coated with a thin aluminum film.

45 [0021] The invention described in claim 3 refers to a combustion promoting device according to either of claim 1 or 2, in which said substrate is coated with a thin copper film.

[0022] Further, the invention described in claim 4 refers to a method for using a combustion promoting device, in which said combustion promoting device is attached to an induction system of an internal combustion engine so as to promote combustion within a combustion chamber, said combustion promoting device comprising a heat resistant substrate with ceramic and titanium oxide attached thereto for dispersing ionized clusters of cohering atoms or molecules charged with electricity and for making said ionized clusters into fine particles, said ionized clusters constituting the air to be supplied into said combustion chamber of said internal combustion engine.

50 [0023] There is no particular restriction to where to install a combustion promoting device in an induction system of an internal combustion engine. For example, the device may be installed on the outer or inner surface of an air intake duct, or may be formed into a predetermined shape of a filter or a small lump to be attached inside the duct.

55 [0024] Such a means as a heat resistant bonding agent, an adhesive tape (single-faced), a double-faced adhesive tape may be employed for sticking a combustion promoting device to the induction system. As a heat resistant tape, for example, a ceramic tape may be employed which is flexibly solidified out of paste of organic urethane emulsion

base kneaded with a proper amount of ceramic power. Besides them, other attaching means may be employed, for example, a fastener such as a heat resistant string or a wire, male/female mating surfaces for tight fit between the induction system and the device, or a catcher such as a hook.

[0025] The combustion device may detachably be attached to this induction system or may be fixed thereto so as not to easily separate therefrom.

[0026] When a diesel engine is employed as an internal combustion engine, positive ions emitted from ceramic and titanium oxide may act not only on air as described above but also act on engine cooling water. This makes ionized clusters of molecule of the engine cooling water into fine particles and thereby enhances cooling efficiency.

[0027] According to the present invention, positive ions emitted from ceramic and titanium oxide neutralizes ionized clusters of various atoms and molecules constituting a combustible fluid for a combustion equipment. This neutralization allows these ionized clusters to be dispersed and made into fine particles, and thereby enhances the combustion efficiency of the combustion equipment. Consequently, the content of such harmful substances as NOx, SOx, HC in the exhaust gas is reduced and the life of the combustion equipment is also made longer.

[0028] In particular, according to the invention claimed in claim 4, when a combustible fluid is attached to an induction system whose downstream end is connected to a combustion chamber, ionized clusters in the air passing through the induction system are neutralized by positive ions emitted from ceramic and titanium oxide. As a result of this neutralization, the ionized clusters of atoms and molecules constituting the air, especially the ionized clusters of oxygen which reacts with fuel during the combustion reaction are dispersed and made into fine particles, and consequently the combustion efficiency is enhanced and the fuel economy and the power of the internal combustion engine are improved.

[0029] The above mechanism will be detailed below. Since the combustion promoting device has at its core a special ceramic, which emits super electromagnetic wave and is covered with specially-processed glass fiber, it operates as follows. The molecules of oxygen, nitrogen, and the like in the air do not exist independently by themselves, but multiple molecules link together like a chain through ionic bond. This prevents a complete combustion in an internal combustion engine. Therefore a complete combustion can be achieved by loosening this ionic bond and separating the molecules one another. Here the special ceramic emits a faint electromagnetic wave, and when the wave strikes various metals, positive ions are produced. This positive ion discharges its electron and neutralizes the negative ion of oxygen in the fluid (intake air) and thereby inhibits ionic reactive function. Since this combustion promoting device also emits faint magnetism, oxygen as magnetic substance is dispersed so as to align quickly with each other in the direction of line of magnetic force. As a total result of these actions, for example, negative ions (oxygen) in an air cleaner are discharged and neutralized, and the cohering fluid of oxygen is made into a faintly magnetized fluid which is finely dispersed. Consequently, a negative pressure is produced at an air intake portion, and an effective combustion of fuel can be achieved. Consequently, the content of harmful constituents in the exhaust gas is reduced, the black smoke is also reduced, the fuel economy is improved, and the power is increased.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030]

Fig. 1 is an exploded perspective view of a combustion promoting device of an embodiment according to the present invention;

Fig. 2 is a schematic planar view showing how a combustion promoting device of an embodiment according to the present invention is used;

Fig. 3 is a perspective view of a combustion promoting device of an embodiment according to the present invention;

Fig. 4 is an enlarged sectional view of a main portion of a combustion promoting device of an embodiment according to the present invention; and

Fig. 5 is a schematic view illustrating a process how ionized clusters in the air are dispersed and made into fine particles by positive ions emitted from ceramic and titanium oxide,

wherein the reference numerals 10, 12, and 15 designate a combustion promoting device, an engine (a combustion equipment, an internal engine) and a glass cloth (a substrate) respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0031] A combustion promoting device of an embodiment according to the present invention and a method for using it will hereafter be described. A gasoline engine, that is, one of internal combustion engines, is described as an example of a combustion equipment.

[0032] Fig. 1 is an exploded perspective view of a combustion promoting device of an embodiment according to the present invention. Fig. 2 is a schematic planar view showing how a combustion promoting device of an embodiment

according to the present invention is used. Fig. 3 is a perspective view of a combustion promoting device of an embodiment according to the present invention. Fig. 4 is an enlarged sectional view of a main portion of a combustion promoting device of an embodiment according to the present invention. Fig. 5 is a schematic view illustrating a process how ionized clusters in the air are dispersed and made into fine particles by positive ions emitted from ceramic and titanium oxide.

[0033] In Fig. 2, the reference numeral 10 shows a combustion promoting device according to the present invention, and this combustion promoting device 10 is detachably stuck to an outer face of a bellows rubber hose 13a of an air intake duct (induction system) 13 of an engine 12 installed in an engine compartment 11 of a vehicle. The combustion promoting device 10 will hereafter be detailed with the reference to Figs. 1, 3, and 4.

[0034] The combustion promoting device 10, as shown in Figs. 1 and 3, is wrapped by a packaging metal film 14, which has on its back a separation paper 14a, whose thickness is 100 μm , whose size is 90 mm x 90 mm and which is made by Rintech Company.

[0035] As shown in Fig. 4, the combustion promoting device 10 has a glass cloth 15 (1 mm in thickness, 40 mm in width, and 195 mm in total length), which has a substrate of twill-woven glass fiber and has a vapor-deposited aluminum film 16 of 100 μm thickness on its one side and is folded in three.

[0036] As a concrete glass cloth 15 having a aluminum film 16, an aluminum twill-woven glass cloth adhesive tape (heat resistant temperature 180°C) made by Japan Glass Fiber Company is employed. A glass cloth with no aluminum film 16 vapor-deposited may also be employed. For example, Nitofron adhesive tape (973UL) made by Nitto Denko Corp. is such one. Nitofron (product name) is a porous membrane of ethylene tetra-fluoride resin which allows such gases as air, steam to pass through but does not usually allow solid fine particles and such liquids having a wide contact angle as water, sulfuric acid to pass through. The tape is 0.13 to 0.18 in thickness and 10 to 450 mm in width. Tyuko Flow adhesive tape (AGF-100/AGF-100A, heat resistant temperature 200 °C /250 °C, respectively) made by Tyuko Chemical Company may be employed. These tapes are PTFE-impregnated glass cloths. Such other cloths as Valfron (product name; Valfron 7910, 7925; made by Nihon-Valqua Industries, Ltd.), "Permacel" (product name), glass cloth made by Asahi Glass Co., Ltd., glass cloth of Toshiba Ceramics Co., Ltd. may be employed.

[0037] Supertherm (sales product name in Japan; Ceramotherm) made by Superior Product Company in the US is applied onto the surface of said aluminum membrane 16. The applied amount herein is about 1 g/cm², but is not restricted thereto. Supertherm is a heat insulative coating agent comprising a base of organic urethane emulsion and acrylic resin emulsion and being compounded with 700 kinds of ceramics. Supertherm includes 6 weight percent of titanium oxide as constituent. Since Supertherm is spray-applied, it is easy to handle.

[0038] On the other hand, using a heat resistant double-faced adhesive tape 17 made by Nitto Denko Corp., a sheet of copper foil 18 of 200 μm (or 300 μm) in thickness is stuck onto the other surface of this glass cloth 15. In stead of this copper foil 18, a copper piece may be wound up into the folded glass cloth 15.

[0039] It will hereafter be described how to use this combustion promoting device.

[0040] To use this combustion promoting device 10, a vehicle bonnet is opened as shown in Fig. 2, and the combustion promoting device 10 is stuck to the outer surface of a bellows rubber hose 13a of a air intake duct 13 of an engine 12, using a heat resistant double-faced adhesive tape 20 (refer to Fig. 3). Then, when the engine 12 is driven, the ionized clusters in the air supplied through an induction duct 13 into a combustion chamber of the engine 12 are neutralized by the ceramic and titanium oxide of the combustion promoting device 10.

[0041] That is, various ionized clusters constituting the air, especially the ionized clusters of oxygen are neutralized by the ceramic and titanium oxide. Through this neutralization, these ionized clusters are dispersed and made into fine particles (refer to Figs. (a) to (c)).

[0042] Consequently, ionized clusters of oxygen which reacts with gasoline (fuel) and causes the combustion reaction are dispersed and made into fine particles, and this enhances the combustion efficiency of the engine 12 and results in improved fuel economy and higher power. Further this higher power leads to an improved accelerability of the engine 12, which in turn prevents the degradation in the instantaneous passing ability or the speed down at an upward slope. Further the engine noise is reduced and the black smoke contained in the exhaust gas is drastically reduced, and thereby the content of harmful substances such as NO_x, SO_x, HC is also reduced. Therefore this can contribute to the environment preservation. Furthermore the life of the engine 12 is made longer.

[0043] A result in an actual vehicle running test, conducted by the inventor, using an embodiment of this combustion promoting device is hereafter described.

[0044] First is described a measurement result in a test in which how much black smoke is exhausted from a Nissan Gloria equipped with a diesel engine (2800cc). A smoke tester made by Baccaruck Company was used for this measurement. Before installing a combustion promoting device 10, the content of black smoke in the exhaust gas was 47 % with respect to a specified amount. After installing a combustion promoting device 10, the content of black smoke was reduced to 23 %.

[0045] Then a test was conducted to measure hydrocarbon (HC) in the exhaust gas. In this test a motor bicycle of Honda supercab (50cc) was used. The HC in the exhaust gas was 480 ppm before installing the device. The HC after

installing the device was reduced by 190 ppm to 290 ppm. The measuring instrument in this inspection was CO-HCC ANALYZERALTAS-1000 made by IYASAKA Company.

[0046] Then gasoline-powered car with a combustion promoting device 10 equipped was rendered to a test by a foundation, Japan Automobile Transport Technology Association to examine how the exhaust gas was improved.

[0047] The conducted tests were an exhaust gas test at idle before and after installing a combustion promoting device 10 into an air cleaner, and an exhaust gas test at Japan 10 mode for a gasoline-powered car.

[0048] The tested car had such specifications as Model name/type; Toyota E-GX81, Registered number; Kyoto 53 9540, Vehicle identification number; GX81-3301780, Category/usage; small passenger car, Engine type; 1G, Cycle/number of cylinders; 4 cycle/6 cylinders, Displacement; 1988cc, Max power; 135PS/5600rpm, Normal idle engine rev; (N) 700± 50 rpm, category of anti-pollution measure; three way catalyst + O₂ sensor, Fuel category; lead-free gasoline, idle ignition timing; 10 deg/700 BTDC, Transmission; Automatic(4 stages forward), FGR; 4.100, Vehicle weight; 1360 kg, Tested vehicle weight; 1470 kg, Equivalent inertia weight; 1500kg.

[0049] The measuring instruments used in the test were a chassis dynamometer (RDDY, type-1210, made by Horiba, Ltd.), an exhaust analyzer (MEXA, type-8420, made by Horiba, Ltd.), and an exhaust gas sampler (CVS, type-9100, made by Horiba, Ltd.).

[0050] Table 1 shows a result of the exhaust gas at idle test. Table 2 shows a result of the exhaust gas and fuel consumption at 10 mode test.

Table 1 Result of Exhaust Gas Test at Idle

item			before installed		after installed		
test date			May 12, 1999 (weather fine)		May 12, 1999 (weather fine)		
total mileage before test (km)			92603		92635		
test room	atom. pressure mm Hg		760.4		760.0		
	t e m p	dry bulb °C	24.2		24.8		
		wet bulb °C	17.8		18.2		
		relative humidity %	53		53		
test car	coolant temp °C		87		86		
	lubricant temp °C		96		99		
e x g h a s u s t	gear position		N	D	N	D	
	engine revolution rpm		694	592	699	617	
	induction pressure mmHg		539	434	541	488	
	*	measured value (NDIR)	CO %	0.08	0.01	0.05	0.01
			HC ppm	114	10.3	88.0	12.0
			CO ₂ %	14.2	13.8	14.2	13.9
		corrected conc.	CO %	-	-	-	-
			HC ppm	-	-	-	-

* constituent

Table 2 Exhaust Gas and Fuel Consumption at Japan 10 Mode Test

item		before installed			after installed				
date of test		May 12, 1999 (weather fine)			May 12, 1999 (weather fine)				
total mileage before test km		92603			92635				
test room	atom. pressure	760.4			760.0				
	t e m p	dry °C			24.6-24.4				
		wet °C			18.4-17.8				
	humidity %		53			54			
test car	coolant temp°C	86-86			86-87				
	lubricant temp°C	95-96			97-96				
*	speed (Km/h)	20	40	60	20	40	60		
	resistanc e kg	23.8	29.2	38.1	23.8	29.2	38.1		
KH (humidity correction factor)		0.989			0.986				
constituent measuring method		CO ppm (NDIR)	HC ppmC (FID)	CO ppm (CLD)	CO ₂ % (NDIR)	CO ppm (NDIR)	HC ppmC (FID)	CO ppm (CLD)	CO ₂ % (NDIR)
diluted exhaust gas concentration		54.5	18.48	19.88	0.70	45.4	12.85	16.57	0.77
diluted air concentration		0.9	2.36	0.05	0.04	0.7	2.15	0.04	0.05
net conc.		53.65	16.24	19.83	0.66	44.74	10.81	16.53	0.72
exhausted weight		1.32	0.20	0.79	255	1.11	0.14	0.66	251
sample amount m ³ /min		6.21			6.21				
fuel consumption (carbon balance) km/l		9.2			9.4				

* running resistance setting value for chassis dynamometer

[0051] As obviously seen in Tables 1 and 2, CO, NO_x, and HC in the exhaust gas were reduced by installing the combustion promoting device 10. Especially, the reduction was remarkable at 10 mode.

[0052] According to the present invention, since ceramic and titanium oxide are attached to a heat resistant substrate, they neutralizes ionized clusters of a combustible fluid, disperse and make the clusters into fine particles, the combustion efficiency of a combustion equipment is enhanced. Accordingly the content of harmful substances such as NO_x, SO_x, HC is reduced and the life of the combustion equipment is made longer.

[0053] In particular, according to the invention described in claim 4, since a combustion promoting device is attached to an induction system of an internal combustion engine, ionized clusters of various atoms and molecules constituting the air, especially ionized clusters of oxygen, are dispersed and made into fine particles, and consequently the combustion efficiency is enhanced and thereby the fuel economy and the power of the internal combustion engine can be improved.

[0054] As many apparently widely different embodiments of this invention may be made without departing from the

spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.

5 **Claims**

1. A combustion promoting device comprising a heat resistant substrate with ceramic and titanium oxide attached thereto for dispersing ionized clusters of cohering atoms or molecules charged with electricity and for making said ionized clusters into fine particles, said ionized clusters constituting a combustible fluid to be supplied into a combustion equipment and to cause a combustion reaction.
10
2. A combustion promoting device according to claim 1, in which said substrate is coated with a thin aluminum film.
3. A combustion promoting device according to either of claim 1 or 2, in which said substrate is coated with a thin copper film.
15
4. A method for using a combustion promoting device, in which said combustion promoting device is attached to an induction system of an internal combustion engine so as to promote combustion within a combustion chamber, said combustion promoting device comprising a heat resistant substrate with ceramic and titanium oxide attached thereto for dispersing ionized clusters of cohering atoms or molecules charged with electricity and for making said ionized clusters into fine particles, said ionized clusters constituting the air to be supplied into said combustion chamber of said internal combustion engine.
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Fig. 1

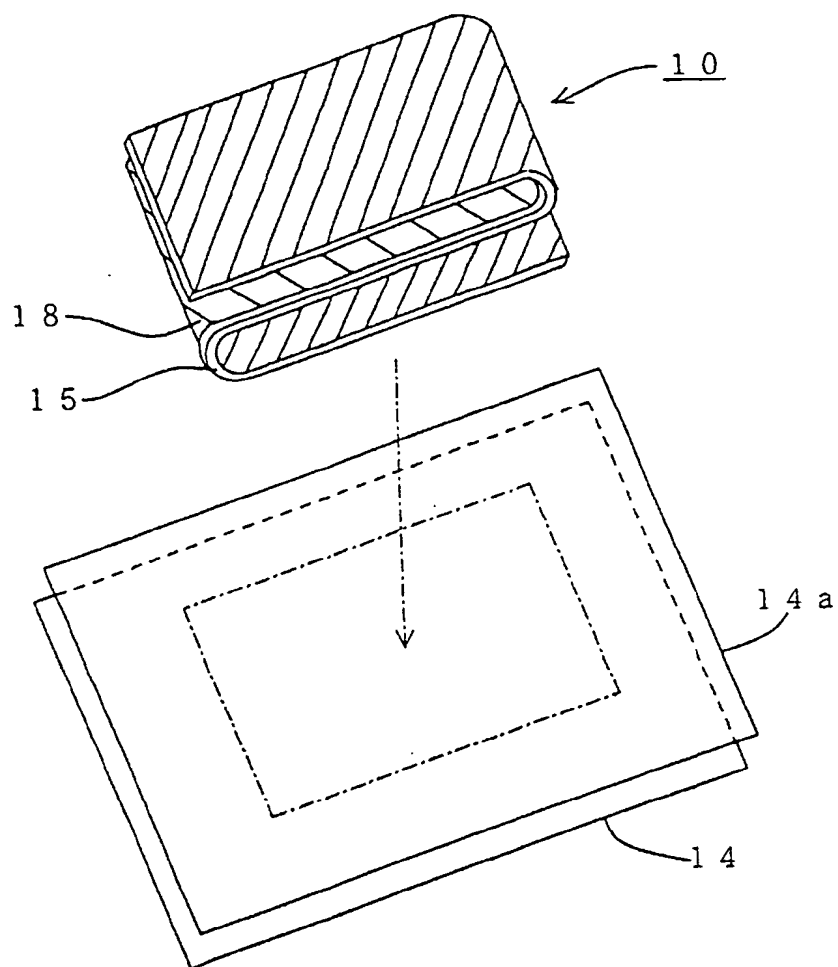


Fig. 2

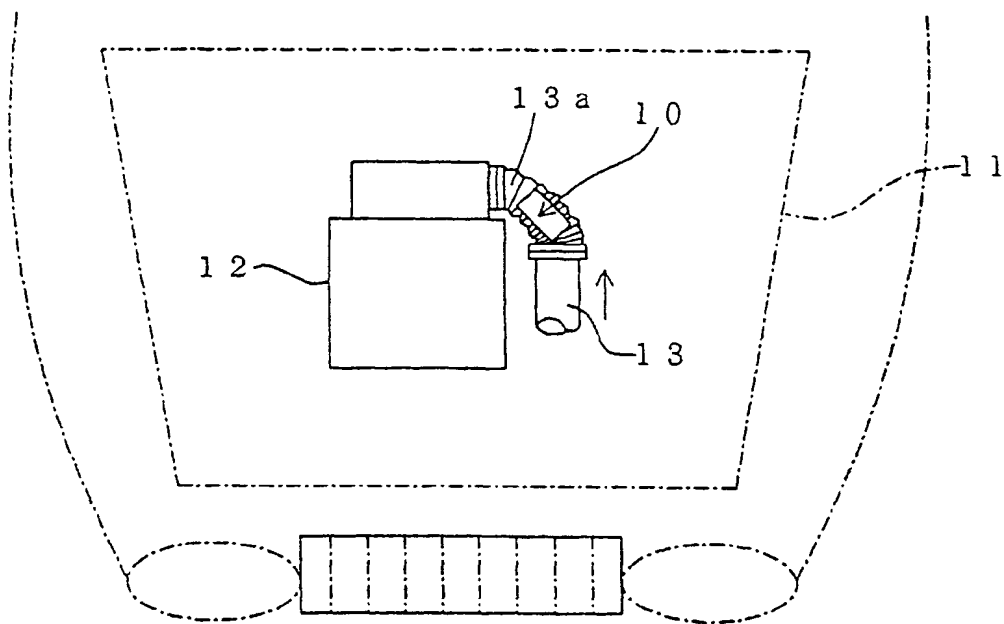


Fig. 3

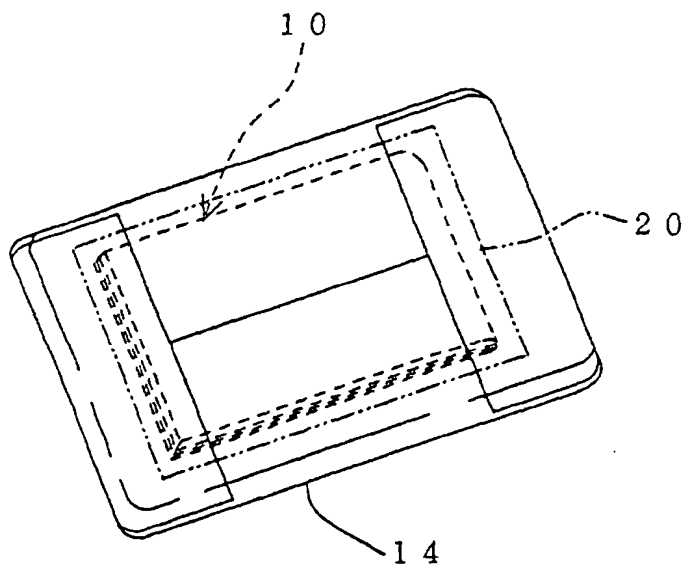


Fig. 4

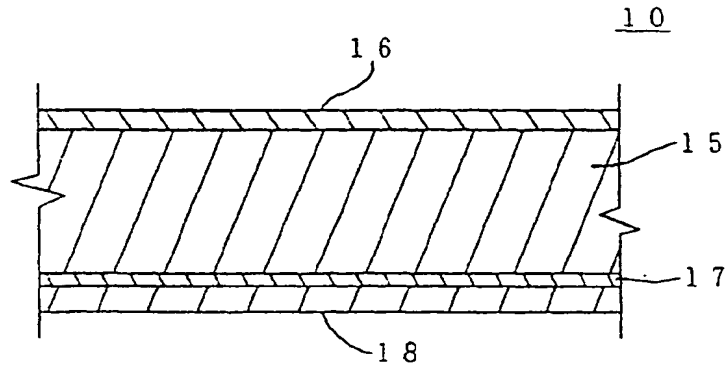


Fig. 5(a)

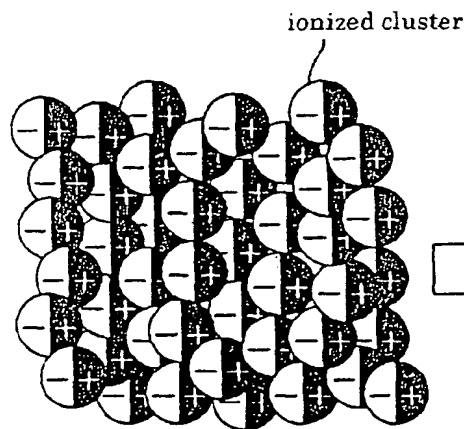


Fig. 5(b)

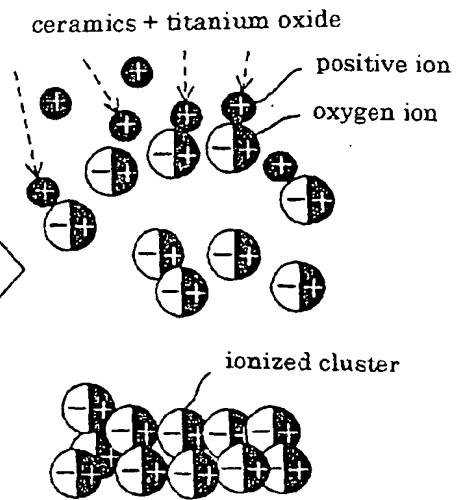
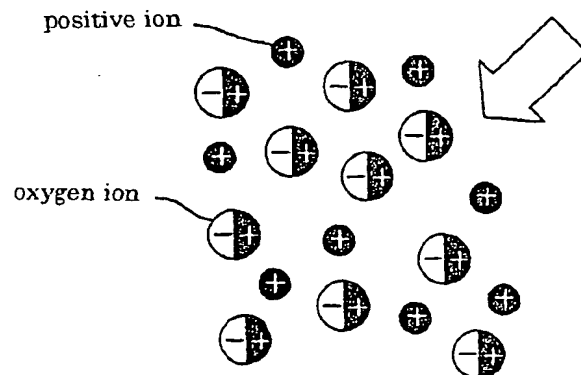


Fig. 5(c)





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 11 6490

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Y	WO 99 23382 A (HAN GUEN SUB; KIM SANG KYEONG (KR)) 14 May 1999 (1999-05-14)	1-3	F02M27/02
A	* abstract; claims 1,3; figures 4-6,8 * * page 5, line 4 - page 6, line 23 * * page 9, line 20 - page 10, line 2 * * page 11, line 18 - page 13, line 16 * * page 17, line 1 - line 5 * * page 17, line 28 - page 22, line 6 *	4	
Y	US 3 657 063 A (BROWN SHERMAN D ET AL) 18 April 1972 (1972-04-18) * abstract; claims 1-4 * * column 1, line 4 - line 17 * * column 2, line 1 - line 42 *	1-4	
Y	GB 2 339 240 A (WANG YIN-JUNG) 19 January 2000 (2000-01-19)	4	
A	* abstract; claim 1; figures 4,6 * * page 2, line 24 - page 3, line 24 *	1-3	
A	US 5 111 797 A (SHIKANAI YASUSHI) 12 May 1992 (1992-05-12) * abstract; claims 1-5,8,9; figures 1-3 * * column 2, line 31 - column 3, line 15 *	1-4	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A	EP 0 791 745 A (NISHIKAWA NOBUYOSHI) 27 August 1997 (1997-08-27) * abstract; claims 13-17; figures 2,4-6 * * page 4, line 7 - line 16 * * page 4, line 56 - page 5, line 16 * * page 5, line 50 - page 6, line 45 * * page 7, line 25 - line 41 *	1-4	F02M F02B F23C F23D F02F C04B
-/--			
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 19 December 2000	Examiner Döring, M
CATEGORY OF CITED DOCUMENTS X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons &: member of the same patent family, corresponding document			

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EUROPEAN SEARCH REPORT

Application Number
EP 00 11 6490

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (InCL7)
A	US 5 632 254 A (KIM YOUNG S) 27 May 1997 (1997-05-27) * abstract; claims 1-3,6,9; figure 2 * * column 1, line 59 - column 2, line 23 * * column 2, line 55 - column 3, line 15 * * column 3, line 64 - column 4, line 31 * ---	1-3	
A	EP 0 708 237 A (IBE CO LTD) 24 April 1996 (1996-04-24) * abstract; figure 3 * * page 3, line 1 - line 17 * * page 3, line 34 - line 49 * -----	1,4	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
Place of search THE HAGUE		Date of completion of the search 19 December 2000	Examiner Döring, M
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

EPO FORM 1503 03/88 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 00 11 6490

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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19-12-2000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9923382 A	14-05-1999	AU 5235498 A	24-05-1999
		CN 1244234 A	09-02-2000
		EP 0954693 A	10-11-1999
		JP 2000510550 T	15-08-2000
US 3657063 A	18-04-1972	NONE	
GB 2339240 A	19-01-2000	NONE	
US 5111797 A	12-05-1992	NONE	
EP 0791745 A	27-08-1997	NONE	
US 5632254 A	27-05-1997	NONE	
EP 0708237 A	24-04-1996	JP 7224730 A	22-08-1995
		AU 2148095 A	30-10-1995
		WO 9527849 A	19-10-1995
		US 5695531 A	09-12-1997

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82